

# Smart Elastomer Seal with Remote Monitoring for Condition Based Maintenance, Phase I

Completed Technology Project (2018 - 2019)



## Project Introduction

NASA is developing a common launch infrastructure to support multiple types of rockets. In order to reduce cost and simplify service of infrastructure, automation of multiple processes is highly desirable. In this approach, Autonomous Control Technologies perform functions such as anomaly and fault detection, fault isolation, diagnostics and prognostics for critical components. There is a clear need for instrumented monitoring of critical seal components of the propellant delivery system, since a loss of propellant lines integrity can cause great damage, as learned from the Challenger accident, which was caused by a faulty O-ring. A team of physicists and engineers from AT-Tek will design, fabricate, and test an inexpensive elastomer seal with an embedded sensor that can be in-situ-interrogated by compact electronics built into the vacuum flange. The integrated "smart seal" package can self-monitor such parameters as compression and elasticity of the seal material, both of which are critical for preventing catastrophic seal failures. Compared to previous attempts, AT-Tek's novel approach will dramatically increase the sensitivity of the detection of critical seal parameters and realize a practical smart seal for the first time. The ultimate goal of this innovation is to integrate a smart seal into an autonomous propellant management infrastructure, thus enabling **condition-based maintenance** (not time-based) of critical elastomer seals for the first time. Another advantage of seal monitoring is ability to detect degradation of the seal before actual failure, with an option to adjust process parameters (pressure, temperature, etc) or bypass the degrading connection without aborting the process. This will minimize the risk of failure even if maintenance of degrading seal is not readily possible. If successful, the AT-Tek smart seal will form another smart asset integrated into NASA's Autonomous Control Technologies system.

## Anticipated Benefits

**Ground Launch Operations (Focus area 16, H10.02):** This innovation introduces smart seals into the autonomous propellant management infrastructure under current NASA development to enhance safety and reduce costs of ground and payload operations.

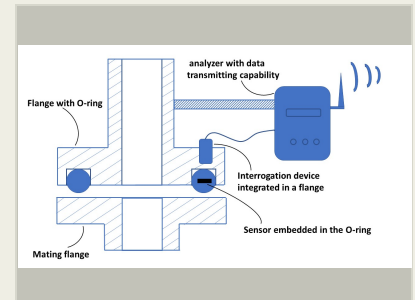
### Life Support and Habitation Systems (Focus Area 6, H6.01, H4.01):

Smart seals for airtight barrier between the internal space of a habitat and an external environment, applications in airlocks, docking systems in habitat structures and space suits.

## Department of Energy

**Nuclear Power Plants:** Reduce risks poised by faulty O-rings in nuclear plants.

**Leak Prevention in Natural Gas Pipelines:** The seals are a frequent cause



Smart Elastomer Seal with Remote Monitoring for Condition Based Maintenance, Phase I

## Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Project Transitions	3
Images	3
Technology Areas	3
Target Destination	3

# Smart Elastomer Seal with Remote Monitoring for Condition Based Maintenance, Phase I

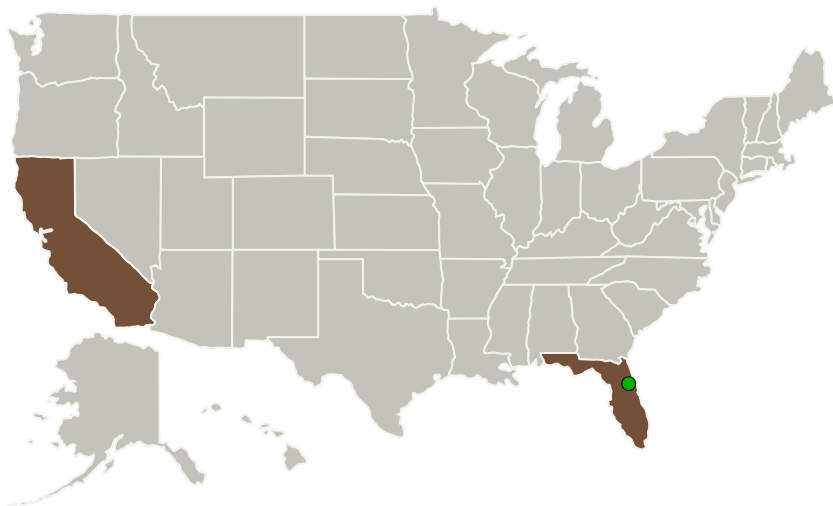
Completed Technology Project (2018 - 2019)



of leaks in pipeline valves; and smart seals are needed to address this deficiency.

**Smart Factories in Multiple Markets:** Microelectronics, Pharmaceuticals, Renewable Energy; The current concept of "smart factories" requires novel sensors to monitor the condition of critical components including ubiquitous elastomer seals.

## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Alexandre	Lead Organization	Industry	Santa Rosa, California
● Kennedy Space Center(KSC)	Supporting Organization	NASA Center	Kennedy Space Center, Florida

Primary U.S. Work Locations	
California	Florida

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Alexandre

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

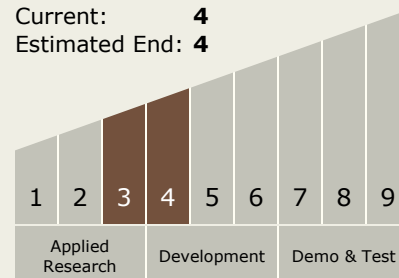
Carlos Torrez

### Principal Investigator:

Alexandre N Terentiev

## Technology Maturity (TRL)

Start: 3  
Current: 4  
Estimated End: 4



# Smart Elastomer Seal with Remote Monitoring for Condition Based Maintenance, Phase I

Completed Technology Project (2018 - 2019)



## Project Transitions



**July 2018:** Project Start

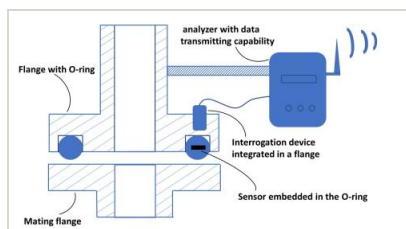


**February 2019:** Closed out

### Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/141300>)

## Images



### Briefing Chart Image

Smart Elastomer Seal with Remote Monitoring for Condition Based Maintenance, Phase I  
(<https://techport.nasa.gov/image/135741>)

## Technology Areas

### Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.1 Infrastructure Optimization
    - TX13.1.7 Impact/Damage/Radiation Resistant Systems

## Target Destination

Earth